SIXTH QUARTERLY PROGRESS REPORT
R-310.6-54, PIB-249.6

on

MEASUREMENT OF RADIO FREQUENCY CABLE

February 1, 1954 to April 30, 1954

for

BUREAU OF SHIPS
Contract No. NObsr-63084
Index No. NE-111616 Subtask 10

MRI

POLYTECHNIC INSTITUTE OF BROOKLYN
MICROWAVE RESEARCH INSTITUTE

Microwave Research Institute
Polytechnic Institute of Brooklyn
55 Johnson Street
Brooklyn 1, New York

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MEASUREMENT OF RADIO FREQUENCY CABLE

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Bureau of Ships

Authors John W. E. Griemsmann
John W. E. Griemsmann
Associate Director

Saul W. Rosenthal
Saul W. Rosenthal
Research Assistant Professor

Title Page
Abstract
9 Pages of Text
4 Pages of Tables
20 Pages of Figures

Approved E Weber
Ernst Weber
Director

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ABSTRACT

An outline is given of the work being done on the program of attenuation measurements of radio frequency cable over the frequency range of 2500 to 10,000 mc/sec. Results of measurements on a second group of cables are given for the frequencies completed to date. Evidence is also presented which leads to the conclusion that the age and past history of cable is of considerable importance in the determination of attenuation values. The program for the evaluation of cable construction as it affects attenuation has been continued and the experimental cables have been measured over the frequency range of 2500 to 10,000 mc/sec. Results are discussed and tentative conclusions seem to indicate the dependence of good attenuation characteristics of RF cables at higher frequencies upon braid construction and the type of material used. The conclusions lead to the belief that from the attenuation standpoint, it may be possible to have a single braided good RF cable at frequencies up to 10,000 mc/sec. Work being done on leakage measurements of some experimental cables at 5000 mc/sec. are discussed.

I. Introduction

The purpose of this contract is to conduct a measurement program on the attenuation characteristics of RF coaxial cables, over a frequency range of from 100 to 10,000 mc/sec. The emphasis is placed upon the 2500 to 10,000 mc/sec. range since there has been little published information over this frequency range and it is also a region where anomalous attenuation behavior has been experienced. These measurements will bring up to date the attenuation specifications of available cables listed in the publication, "Attenuation of Standard RF Cables", Bureau of Ships, Code 817, dated May 1953, and where possible extend the frequency range to 10,000 mc/sec. The program will also include a limited investigation of attenuation as a function of cable construction in the same region.

The measurements on the second group of cables have been completed up to and including 10,000 mc/sec. Data and curves are shown for the five RF cables as well as two additional cables (RG-14/U, RG-74/U) obtained from the Underwater Sound Laboratory. The latter cable is of unknown origin and age and thus lies outside the limits of the present series of measurements. However, the data is presented here for informational purposes.

The group of seven special cables involved in the program of investigating the anomalous attenuation behavior of some RF cables above 3000 mc/sec. have been measured for attenuation up to 10,000 mc/sec. and a tentative evaluation has been made. The results have been studied and seem to indicate dependency of good attenuation characteristics upon braid construction and type of material used. The possibility of obtaining a good single braided RF cable at frequencies up to 10,000 mc/sec. seem quite good.

It was also found that the attenuation behavior of RF cables was a function of the history and age of the particular sample. The program for investigating this matter is discussed.

A leakage measurement program is also described with a view towards correlating leakage data with the anomalous attenuation behavior of cables like RG-8/U.

II Work in Progress

A. Procurement of Test Samples

The total number of sample cables, purchased and government furnished, received to date are as follows.

1.	RG-5A/U*	350 ft.
2.	RG-9A/U*	350 "
3.	RG-10A/U**	521 "
4.	RG-21/U*	200 "
5.	RG-116/U*	143 "
6.	RG-118/U	500 "
7.	RG-11/U*	250 "
8.	RG-85/U	300 "
9.	RG-20/U	500 "
10.	RG-34/U	550 "
11.	RG-18/U**	350 "
12.	RG-141/U**	200 "
13.	RG-58A/U*	200 "
14.	RG-8/U**	300 "
15.	RG-55/U**	300 "
16.	RG-35/U	400 "

In addition we have received samples of RG-14/U and RG-17/U from the Underwater Sound Laboratory, for measurement over the frequency range of 5000 to 10,000 mc/sec. as follows.

17.	RG-14/U**	150 ft.
18.	RG-74/U**	80 "

The following special cables have been received from Surprenant Manufacturing Company.

1. (SP1539) RG-9A/U Core - Single RG-8 type silver copper braid.
2. (SP1540) " " - Single RG-9 " " " (1st braid).
3. (SP1541) RG-9A/U Cable with double Cu braid in place of silver coated Cu.
4. (SP1542) RG-9A/U Cable with a thin dielectric between the two braids.
5. (SP1543) RG-9A/U Cable with a thick dielectric between the two braids.
6. (SP1544) RG-9A/U Core - Single RG-8 type silver coated copper braid and armour with dielectric in place of the jacketing material
7. (SP1545) RG-9A/U Cable with 1st braid RG-8 type silver coated Cu braid. All else the same.

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* Samples used in the first set of measurements.

** Samples used in the second set of measurements.

B. Procurement of Connectors

Conneotors and adapters have been obtained for most of the cables involved in the measurement program. It has also been possible to adapt connectors for use with the special cables. However good RF conneotors have not yet been obtained for RG-34/U, RG-118/U, RG-20/U and RG-85/U.

C. Measurement Program

Measurements were continued on the second set of cables up to and including 10,000 mc/sec. The cables are as follows and include RG-14/U and RG-74/U.

	Cable Type	Total Length	Connectors Used	Nominal Impedance
7.	RG-8/U	300 ft.	UG-21D, UG-23D	52.0
8.	RG-10/U	521 "	UG-21D, UG-23D	52.0
9.	RG-55/U	300 "	UG-88/U, UG-89/U	53.5
10.	RG-18/U	350 "	UG-167A/U	52.0
11.	RG-141/U	200 "	UG-88/U, UG-89/U	50.0
12.	RG-14/U	150 "	UG-204B	52.0
13.	RG-74/U	74	UG-204B	50.0

The measurement method is that described in previous reports, using equipment and arrangement as shown in Figs. MRI-13096 and MRI-13907.

These cables with the exception of RG-14/U and RG-74/U were measured at 2500, 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10,000 mc/sec. RG-14/U and RG-74/U were measured at the same frequencies beginning at 5000 mc/sec. Curves of attenuation vs. frequency for these cables are shown in Fig's. MRI-14206 thru MRI-14212. The results are tabulated in Table I. It should be noted here that RG-14/U and RG-74/U are cables of unknown history and age and as such do not fit into the present measuring program. However, in the absence of additional samples and at the request of the Underwater Sound Laboratory the results are being presented for informational purposes. The values for RG-14 seem to agree with the result obtained by the Underwater Sound Laboratory (see letters, serial nos. 1310-183 and I311-161 and attached curve, Fig. MRI-13916 in Fifth Quarterly Report) up to 7000 mc at which point the values diverge the MRI values inoreasing more rapidly with frequency. This may be due to the age and handling of the partioular cable sample since further measurement seem to indioate much lower values after flexing of the sample. Further investigations into these results are being made. The values for RG-74/U oable are quite different from that obtained by the Underwater Sound Laboratory, however the slope of the attenuation curve is the same. The difference again, may be due to the handling, age and history of the partioular oable.

At the higher frequencies most of the cables begin to exhibit various forms of instability. For example an extreme case would be a change in insertion loss due to hand effect. In less sensitive cases a physical disturbance of the cable will cause a change in reading and it may or may not return to its initial value after testing. This is in part due to the fact that at the higher frequencies where some cables have a high attenuation per foot the sensitivity to any disturbance is extremely high. As a result difficulties were encountered with RG-8/U and RG-18/U where different samples of cable gave different results and offtimes the same sample would vary. In contrast a cable like RG-9A/U is relatively stable under most conditions even at higher frequencies.

The sample of RG-8/U used in these measurements was purchased from a supplier and so little is known of its previous history. From 7000 to 10,000 mc/sec. the attenuation seemed to be a function of the handling of the cable and so a range of results are plotted. The same effects and results are noted for most of the other cables at the higher frequencies which are plotted in a similar manner. These results indicate the dependence of attenuation characteristics on the age and handling of the samples and in order to check this further a small program was set up to test a number of cable samples under different conditions. The initial results show that depending upon the age and amount of flexing and of course the type of cable construction, different values of attenuation are obtainable for the same sample. This is very apparent at the high end of the band and the measurements are being continued to determine its behavior as a function of frequency.

D. Measurement Program on Special Cables

The following special cables were measured for attenuation at frequencies of 2500, 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10,000 mc/sec.

1. (SP1539) RG-9A/U Core - Single RG-8 type silver copper braid.
2. (SP1540) " - Single RG-9 type " " " (1st braid).
3. (SP1541) RG-9A/U Cable with double Cu braid in place of silver coated Cu.
4. (SP1542) RG-9A/U Cable with a thin dielectric between the two braids.
5. (SP1543) RG-9A/U Cable with a thick dielectric between the two braids.
6. (SP1544) RG-9A/U Core - Single RG-8 type silver coated copper braid and armour with dielectric in place of the jacketing material.
7. (SP1545) RG-9A/U Cable with 1st braid RG-8 type silver coated Cu braid. All else the same.

The results are tabulated in Table II and the curves of attenuation vs. frequency are shown in Fig's. MRI-14213 thru MRI-14217, and MRI-14219 and MRI-14220.

Cables No. SP1542 and SP1544, both of which have a dielectric material between two braids gave different results for the different lengths of cable samples measured. In addition any handling of the cable caused a variation in insertion loss. The curves in both cases show the different results obtained in each case. The results are an average of the individual values obtained. In the case of SP1544 the dual values were not evident at 6, 7,&8 kmc/sec. This might indicate that some sort of cavity effect caused the above behavior.

The other special cables can be compared to RG-8/U, RG-9A/U and RG-10A/U over the frequency range measured. It should be noted that they all have an RG-9A/U core and variations of RG-8, 9A and 10A braid and armour.

With respect to attenuation behavior the cables fall into the following four categories.

	Type	Braid Characteristics	Inner Braid Type	Outer Braid Type
1.	RG-9A/U	Double, Silver	9A	9A
	SP1540	Single, Silver	9A	
	SP1543	Double, Silver with thick dielectric between braids	9A	9A
	SP1545	Double, Silver	8	9A
2.	SP1539	Single, Silver	8	-
3.	SP1541	Double, Copper	9A	9A
	SP1544	Single with armour, Silver, polyethylene jacket	8	-
	RG-10A/U	Single with armour, Copper	8	-
4.	RG-8/U	Single, Copper	8	-

The categories are in order of good attenuation characteristics and a study of the results seem to indicate that both the braid construction and braid material play an important part in the attenuation characteristics of an RF cable.

For example all of the cables in category I are similar in attenuation behavior to RG-9A/U, (Fig. MRI-13522). In each case the 1st braid is silver, and in the case of SP1545 where the braid coverage is less, having a double braid seems to produce the same results. However in the case of a RG-9A/U braid coverage the second braid does not seem to have any effect. This is seen by the results on SP1540. Further evidence of this was seen on a single measurement of SP1541 which showed little change in attenuation at 7000 mc/sec. when the outer braid was stripped off.

Category 2 which shows a curve with a slight bend included an RG-8 type cable (SP1539) with silver braid which was better than RG-8 with a copper braid but not as good as a single braided cable with RG-9A type braid. This result seems to point out the advantage of silver over copper as a braid material.

Category 3 which is an RG-10A/U cable with a silver coated copper braid has a polyethylene dielectric between the braid and the armour. This was better than RG-10A/U in attenuation characteristics by virtue of the silver coated copper braid, but as a result of the dielectric in place of a lossy jacketing material the cable was quite sensitive. This may be due to a cavity effect since the braids and armour were tied together at the connectors and it was frequency sensitive. No effect was noticed above 5 kmc/sec. SP1541 and the sample of RG-10A/U used, both fall into category 3 at the higher frequencies.

Category 4 is of course normal RG-8/U and had the poorest attenuation characteristics.

The above results seem to indicate the possibility of a good single braided RF cable for use up to 10,000 mc/sec. This cable would include braid coverage of the type used on RG-9A/U cable and probably a material like silver coated copper. A considerable amount of research into braid characteristics and materials is needed for determining optimum construction of RF cables for use at frequencies above 3,000 mc/sec.

E. Cable Leakage Measurement

Several significant results obtained during the work on cable attenuation are compared in order to determine how the cable braiding influences the attenuation.

Measurements on the single-braided RG-8/U cable show a very rapid increase in attenuation for frequencies above 4.0 kmc/sec. RG-9/U cable has a braid structure different from RG-8/U and does not exhibit this excessive attenuation at high frequencies. A specially made cable having a single braid identical with the inner braid of the RG-9/U cable has the same attenuation characteristic as RG-9/U.

The conclusion can be drawn from the above data that same factor in the braid construction of RG-8/U cable results in the excessive attenuation. The difference in attenuation between RG-8/U and the modified RG-9/U cable can probably be attributed either to an increased resistance at the contacts between the braid wires or to leakage through the braid.

Work was initiated to determine whether leakage through the braid was an important contributing factor to the RG-8/U losses. It is hoped that such data will lead to recommendations for changes in the RG-8/U braid construction giving improved cable performance. The method of measurement of leakage is based on work done under BuShips contract NObsr-52078. A cable sample is enclosed within a concentric coaxial shell after the vinyl coat has been removed. This outer line serves to confine the energy passing through a fixed length of cable braid. A match is placed at the end of the cable and at one end of the outer coaxial line; the other end of the outer coaxial line is shorted. The measured attenuation between the power in the cable and the leakage power is then an indication of the effectiveness of the braid shielding. However, this attenuation value depends on the length of the exposed cable sample, the frequency, and a number of other factors which seem to prevent a direct comparison with results previously obtained under contract NObsr-52078. A direct comparison is made possible by using this attenuation value to calculate a "distributed coupling inductance" parameter characteristic of the braid:

$$L_c = \frac{3.05 \times 10^7 (\epsilon - 1)\sqrt{Z_{01} Z_{02}}\; 10^{-\frac{DB}{20}}}{c\sqrt{2\epsilon(1 - \cos\theta \cos\psi) - 2\sqrt{\epsilon}\sin\theta \sin\psi + (1-\epsilon)\sin^2\theta}}$$

where L_c = leakage inductance in microhenries/foot

c = velocity of light in vacuum in cm/sec. = 3×10^{10}

ϵ = relative dielectric constant of cable dielectric

Z_{01}, Z_{02} = characteristic impedance (ohms) of cable and air line, respectively

db = measured leakage power attenuation

$\theta = 2\pi \ell/\lambda \quad \psi = \sqrt{\epsilon}\,\theta$

ℓ = exposed length of cable

λ = wavelength in air

The leakage power from the two similar cables is then proportional to L_c^2.

Shown in Fig. MRI-14222 is an assembly drawing of a leakage detector originally intended for measurements at lower frequencies, but modified for a leakage measurement above the critical frequency 4.0 kmc/sec. The four screws were adjusted using the equipment of Fig. MRI-14223 until a low VSWR was obtained at a frequency near 5.5. kmc/sec. The right-angle stub support VSWR in the neighborhood of the frequency giving the lowest VSWR is shown in Fig. MRI-14224.

After the stub support was tested, an RG-8/U cable sample manufactured by the F.T. & R. Corporation, previously tested for attenuation, was inserted into the leakage tester. Leakage measurements are planned for the next interval.

F. Braid Coverage and Filling Factor

In an effort to determine some of the factors in the braid construction affecting attenuation some calculations were made with respect to the filling factor and coverage on the braids used in RG-8/U cable and that used as the inner braid in RG-9/U cable. The braids look quite different and are different, with respect to the number of "ends" and "picks per inch" as well as material used. In as much as the attenuation characteristics are considerably different one might expect that the braid coverage and filling factor would exhibit a similar difference. The results are as follows:

	RG-8A/U braid	RG-9A/U inner braid
Filling factor	2.27	2.32
Coverage	93%	94.4%

The above results do not show any significant difference as indicated in the attenuation characteristics. The values were obtained using the following formulas.

$$\text{Filling factor} = \frac{m.n.d\omega}{2D} \left(1 + \frac{\pi^2 D^2}{L^2}\right)^{1/2}$$

where:

D = mean diameter of braid in mm

$d\omega$ = diameter of braiding wire in mm

L = log of braid in mm

m = total number of spindles

n = number of ends/spindle

Coverage $-K = (2F-F^2)(100)$ = percent coverage

where: a = angle of braid with axis of cable

$\tan a = 2\pi \; DP/C$

d = diameter of braid wire in inches

C = number of carriers

D = diameter of braid (I.D.)

$F = NPd/\sin a$

N = number of ends/carrier

P = picks/inch of cable length

G. Program

The program for the final period will include the following.

1. A complete set of curves and data on the cables measured.

2. An evaluation of the affects of age and handling on the attenuation measurements of the cables measured and its relationship to the series of measurements.

3. An evaluation conclusion reached on cable construction as it effects attenuation characteristics.

4. Results of a leakage measurement program on RG-8/U and RG-9/U type cable.

5. An ovaluation of previous data on cable attenuation measurements supplied by the Bureau of Ships.

6. Recommendations for further study.

H. Identification of Personnel

The above work is being carried out thru the efforts of the following personnel:

Dr. J. W. E. Griemsmann	Associate Director	Part Time
Mr. S. W. Rosenthal	Research Assistant Professor	Part Time
Mr. L. Birenbaum	Research Associate Junior Grade	Part Time
Mr. W. Zeliger	Technician	Full Time

TABLE I

Frequency	Cable Type	Sample Lengths	Average Att/100 ft. Buffer Method
2500 mc	RG-8/U	50, 100	13.5
	RG-10A/U	60, 100	13.6
	RG-18/U	100	8.2
	RG-55/U	50, 100	27.6
	RG-141/U	30, 50	24.4
3000 mc	RG-8/U	50, 100	15.9
	RG-10A/U	60, 100	15.6
	RG-18/U	100	9.8
	RG-55/U	50, 100	31.4
	RG-141/U	30, 50	26.5
4000 mc	RG-8/U	50, 100	21.4
	RG-10A/U	50, 100	20.9
	RG-18/U	100	13.3
	RG-55/U	50, 100	39.1
	RG-141/U	30, 50	31.8
5000 mc	RG-8/U	50, 100	33.08
	RG-10A/U	60, 100	30.05
	RG-18/U	100	15.78
	RG-55/U	25, 50	46.6
	RG-141/U	30, 50	35.56
	RG-14/U	100	21
	RG-74/U	81.5	24.96
6000 mc	RG-8/U	30, 50	42.81
	RG-10A/U	30, 40	44.76
	RG-18/U	63, 63, 100	25.4 - 33.6
	RG-55/U	28, 40	55.08
	RG-141/U	30, 50	39.8
	RG-14/U	100	26.75
	RG-74/U	81.5	32.23

TABLE I (cont.)

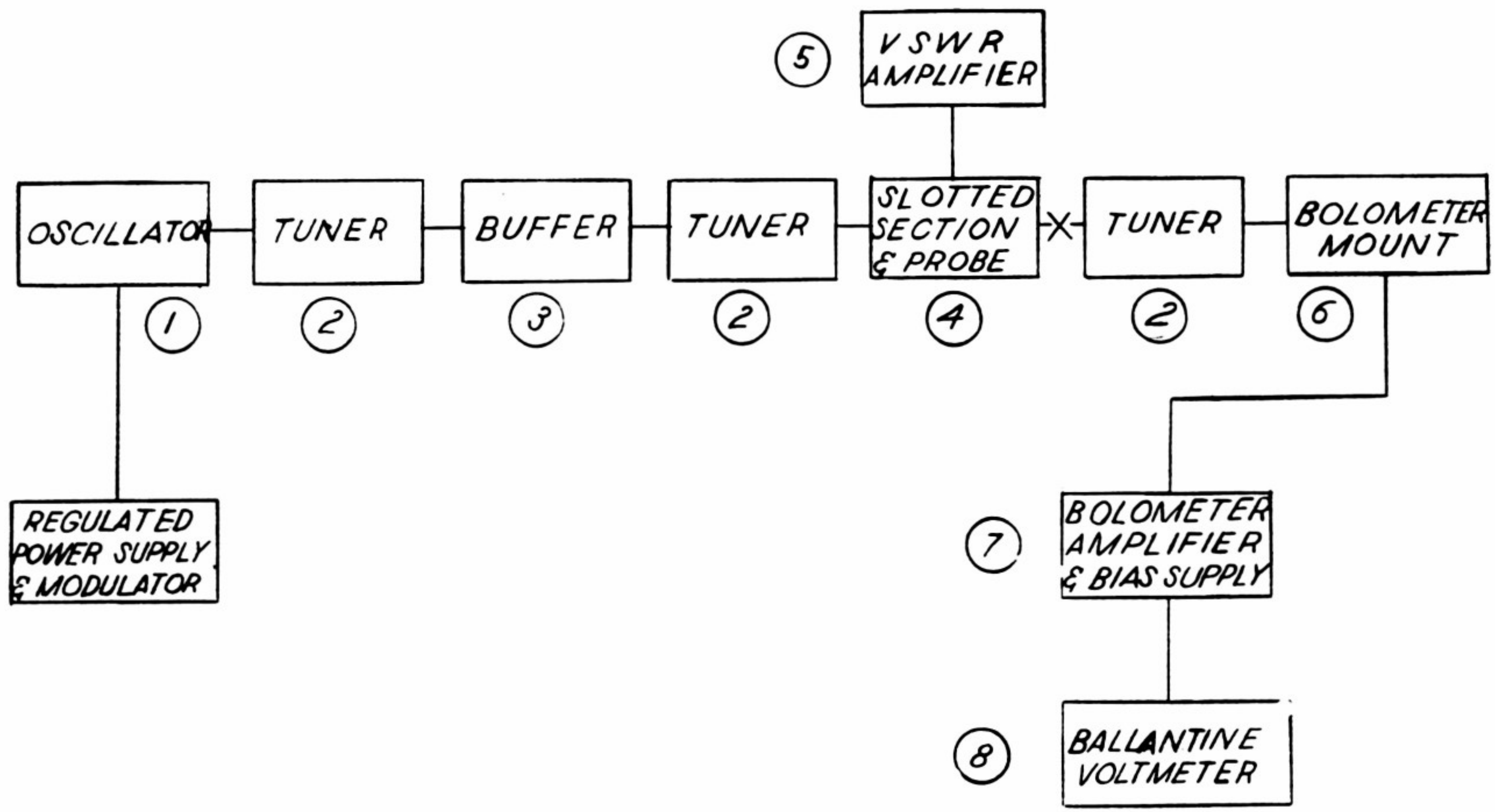
Frequency	Cable Type	Sample Lengths	Average Att/100 ft. Buffer Method
7000 mc	RG-8/U	30, 30, 40, 50	61.7 - 82
	RG-10A/U	30, 40	56.48
	RG-18/U	63, 33, 100	31 - 47.73
	RG-55/U	25, 40	64.13
	RG-141/U	30, 50	44.16
	RG-14/U	100	33.56
	RG-74/U	81.5	33.6
8000 mc	RG-8/U	15, 15	108 - 151.5
	RG-10A/U	30, 30	73.5 - 86.6
	RG-18/U	30, 32.6	50.8 - 100
	RG-55/U	25, 25	81
	RG-141/U	30, 50	48.45
	RG-14/U	50	47.6
	RG-74/U	30, 50	44.45
			Method No. 2
9000 mc	RG-8/U	15, 15, 20	165 - 220
	RG-10A/U	30, 30	85.8 - 105
	RG-18/U	16.3, 25, 16.3, 16.3	56 - 107
	RG-55/U	25, 25, 25	91 - 92.2
	RG-141/U	30, 50	52.88
	RG-14/U	50,	71.5
	RG-74/U	30, 50	60.4
10,000 mc	RG-8/U	15, 15, 20	173 - 248
	RG-10A/U	30, 30	83.5 - 95
	RG-18/U	16.3, 16.3	89 - 101
	RG-55/U	25, 25, 25	110 - 126.8
	RG-141/U	30, 50	59.35
	RG-14/U	25, 25	81.2
	RG-74/U	30, 50	62.75

TABLE II

Frequency	Cable Type	Sample Length	Average Att/100 ft. Buffer Method
2500 mc	SP-1539	50, 100	13.76
	SP-1540	50, 100	15.38
	SP-1451	50, 100	14.63
	SP-1542	50, 100	30.7 - 34
	SP-1543	50, 100	15.34
	SP-1544	40, 50, 100	18 - 22.2
	SP-1545	50, 100	13.81
3000 mc	SP-1539	50, 100	16.13
	SP-1540	50, 100	17.66
	SP-1541	50, 100	16.5
	SP-1542	34.3, 50	36.5 - 41
	SP-1543	50, 100	17.88
	SP-1544	40, 50, 100	19.4 - 21.5
	SP-1545	50, 100	16
3650 mc	SP-1539	50, 100	18.76
	SP-1540	50, 100	20.1
	SP-1541	50, 100	18.71
	SP-1542	34.3, 50	48 - 52
	SP-1543	50, 100	21.05
	SP-1544	40, 50, 100	22 - 27.75
	SP-1545	50, 100	18.3
4000 mc	SP-1539	50, 100	19.57
	SP-1540	50, 100	21.6
	SP-1541	50, 100	20
	SP-1542	34.3, 50	46.6 - 54.5
	SP-1543	50, 100	22.23
	SP-1544	40, 50, 100	24.8 - 29.5
	SP-1545	50, 100	19.5
4500 mc	SP-1539	50, 100	21.3
	SP-1540	50, 100	23.77
	SP-1541	50, 100	22.03
	SP-1542	34.3, 50	48.4 - 52
	SP-1543	50, 100	24.41
	SP-1544	40, 50, 100	27.8 33.4
	SP-1545	50, 100	21.74

TABLE II (Cont.)

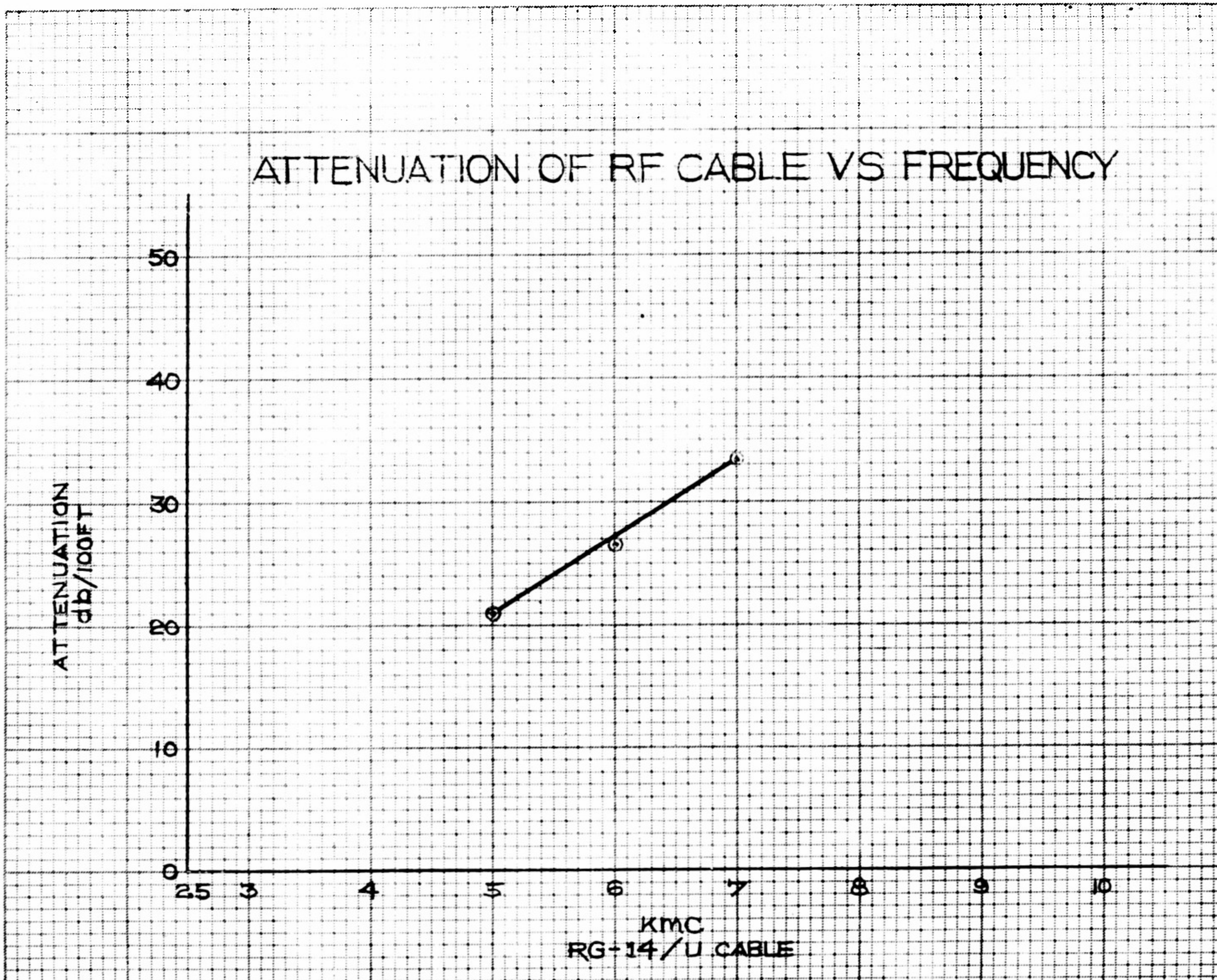
Frequency	Cable Type	Sample Length	Average Att/100 ft. Buffer Method
5000 mc	SP-1539	50, 100	23.89
	SP-1540	50, 100	25.5
	SP-1541	50, 100	24.41
	SP-1542	34.3, 50	49 - 62
	SP-1543	50, 100	25.76
	SP-1544	40, 60, 100	33 - 38.5
	SP-1545	50, 100	23.58
6000 mc	SP-1539	50, 100	28.73
	SP-1540	50, 100	29.5
	SP-1541	50, 100	28.95
	SP-1542	34.3, 34.3	54.3
	SP-1543	50, 100	29.53
	SP-1544	40, 50	41.46
	SP-1545	50, 100	26.69
7000 mc	SP-1539	50, 100	37.95
	SP-1540	50, 100	34.56
	SP-1541	50, 100	38.44
	SP-1542	34.3, 34.3	67.15
	SP-1543	50, 100	33.81
	SP-1544	40, 50	52.25
	SP-1545	50, 100	31
8000 mc	SP-1539	50, 34.3	53.7
	SP-1540	50, 75	38.5
	SP-1541	37.5, 50	59.58
	SP-1542	34.3, 34.3	65.9
	SP-1543	50, 100	37.95
	SP-1544	50, 40	73.73
	SP-1545	50, 100	34.62
9000 mc	SP-1539	50, 34.3	61.07
	SP-1540	50, 75	43.9
	SP-1541	37.5, 50	79.1
	SP-1542	34.3, 34.3	73.9
	SP-1543	50, 100	41.63
	SP-1544	20, 20	75.5 - 123
	SP-1545	50, 100	40
10,000 mc	SP-1539	50, 34.4	70 - 78.5
	SP-1540	50, 75	52.32
	SP-1541	37.5	97.8
	SP-1542	34.3, 34.3	104.25
	SP-1543	50	47
	SP-1544	20, 20	108 - 173
	SP-1545	50	44



BALLANTINE VOLTMETER
ATTENUATION MEASURING SET-UP

3-54

MRI-13096



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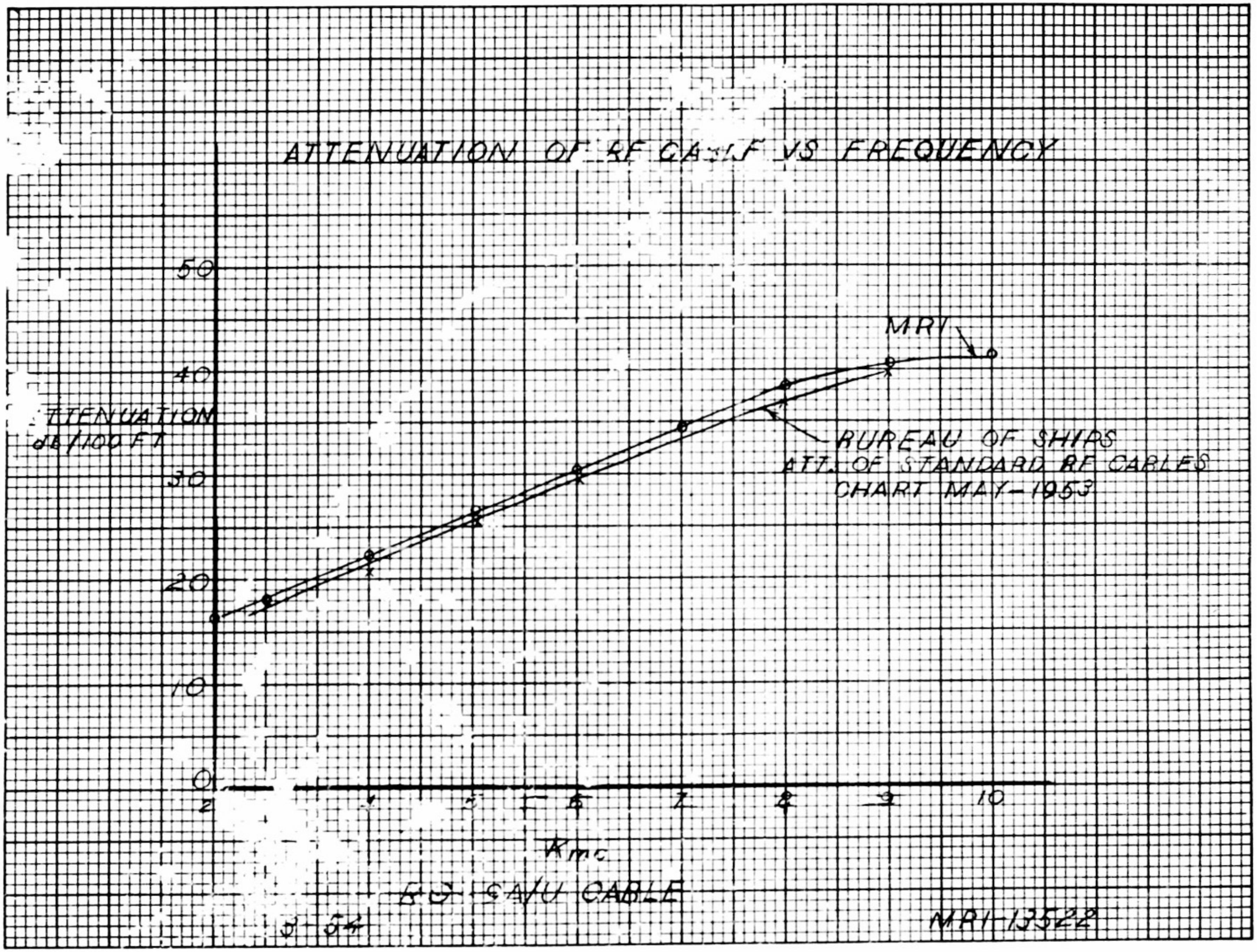
ATTENUATION OF RF CABLE VS FREQUENCY
MRI
BUREAU OF SHIPS
ATT. OF STANDARD RF CABLES
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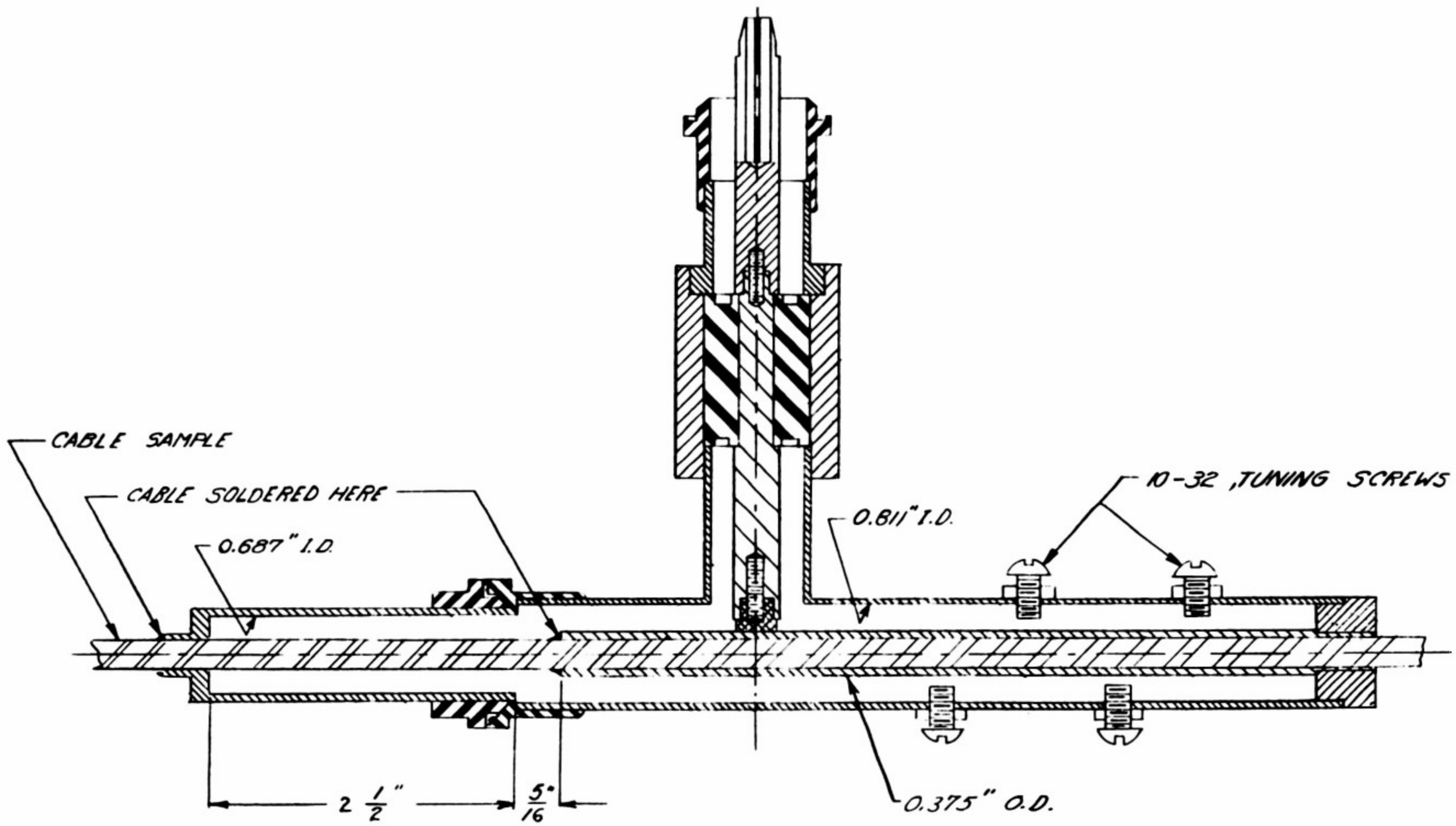
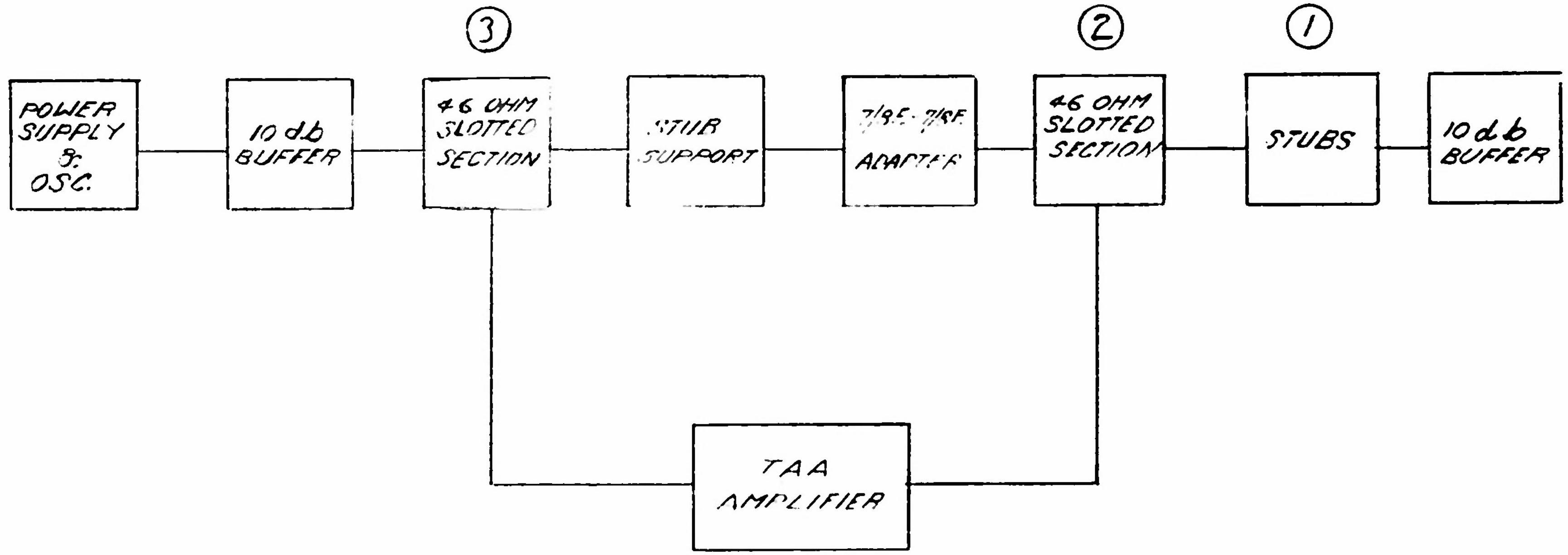
RG 9A/U CABLE
MRI-13522



LEAKAGE TESTER

6-54

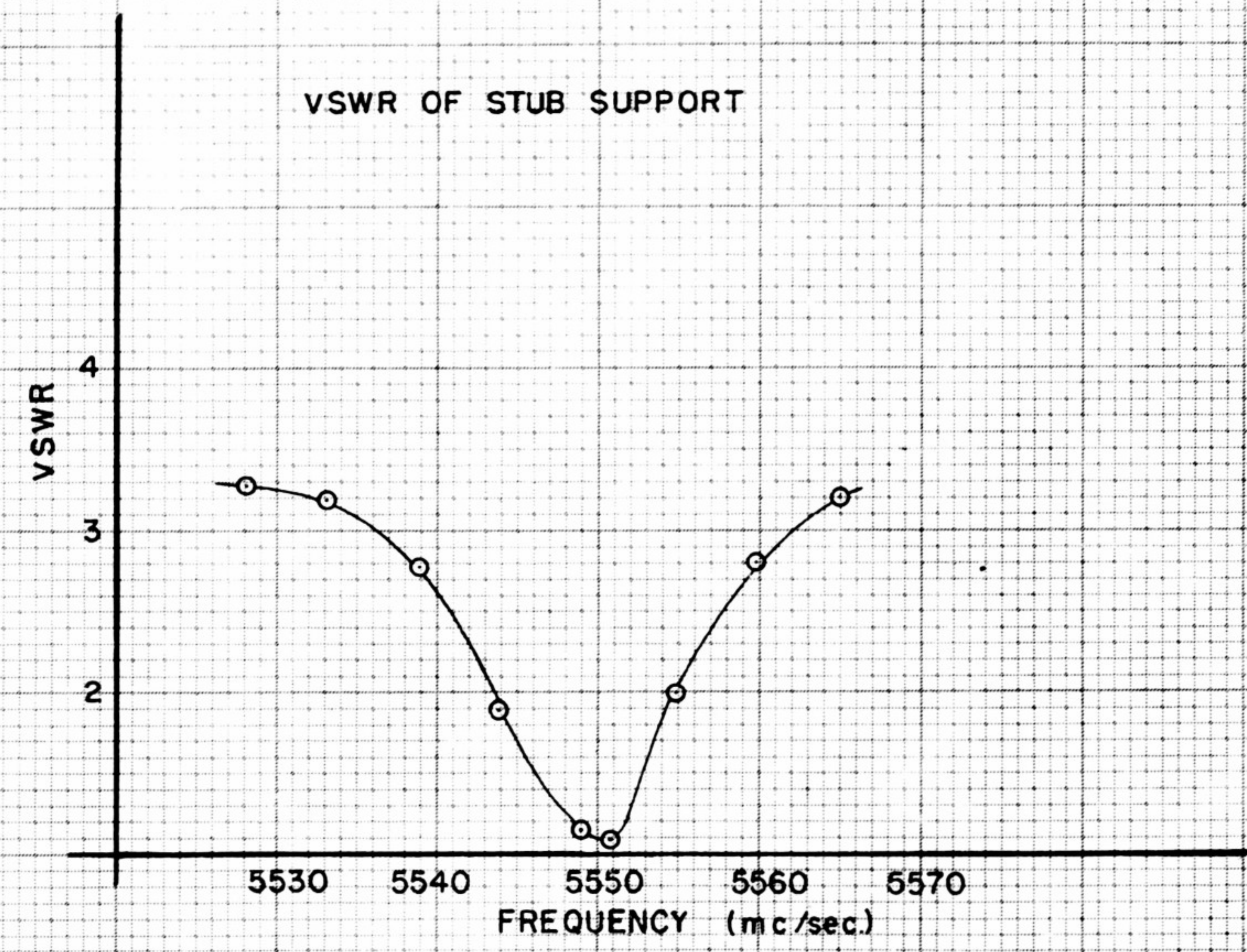
M.R.I.-14222



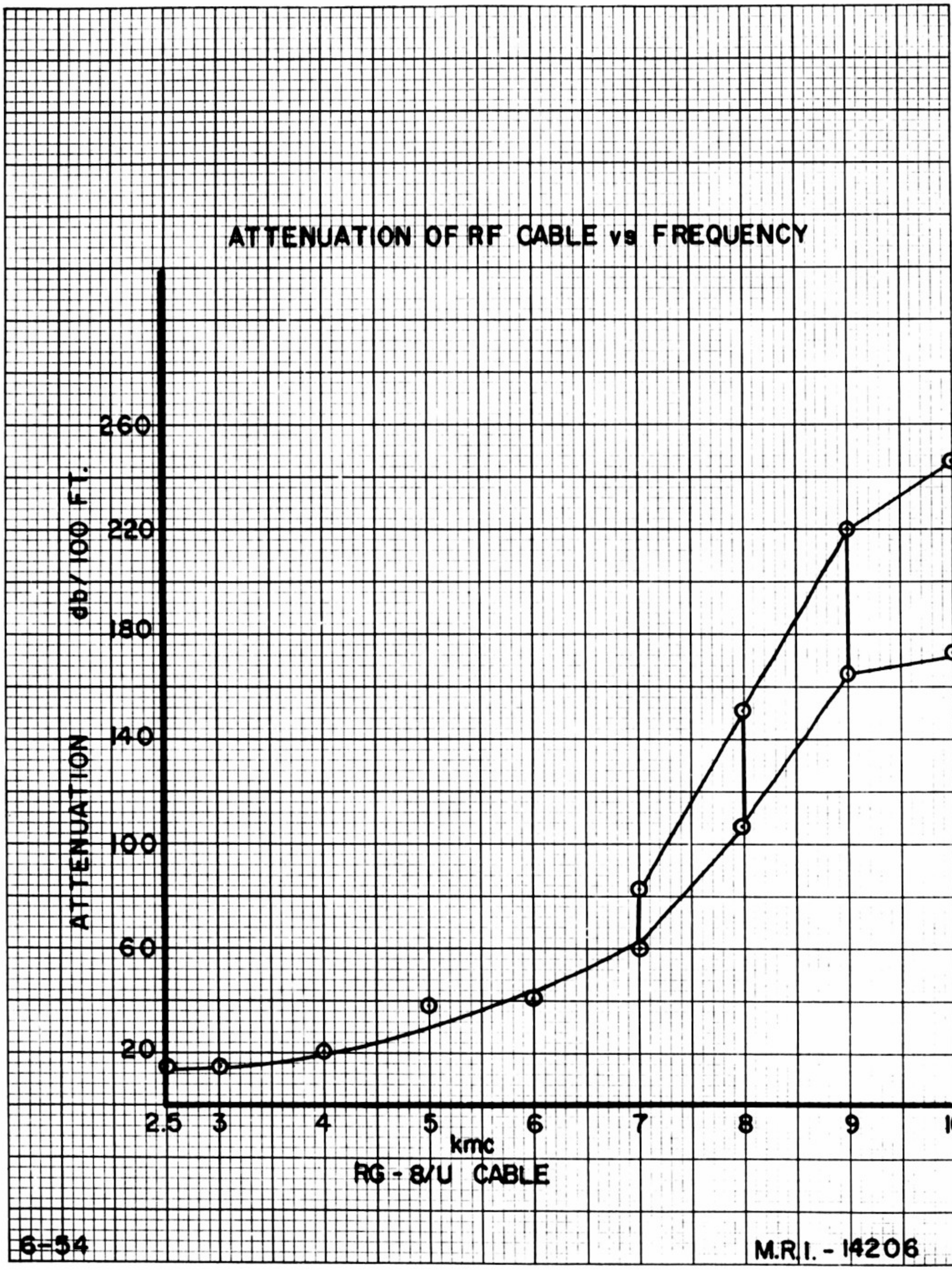
(1) STUBS (1) ADJUSTED UNTIL UNITY VSWR IS READ IN (2)
(2) VSWR IN (3) IS STUB-SUPPORT VSWR

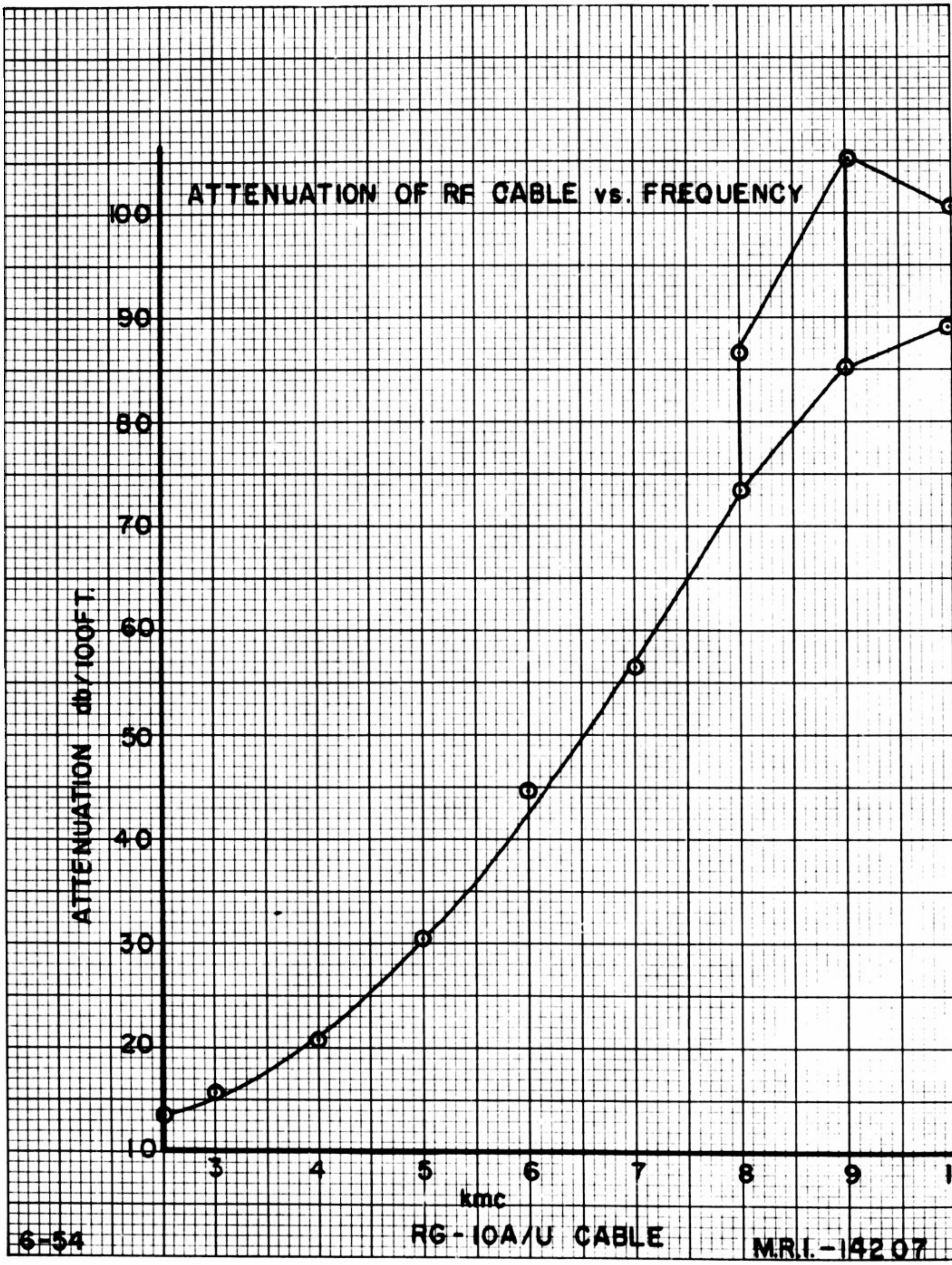
BLOCK DIAGRAM FOR TEST OF LEAKAGE DETECTOR STUB SUPPORT

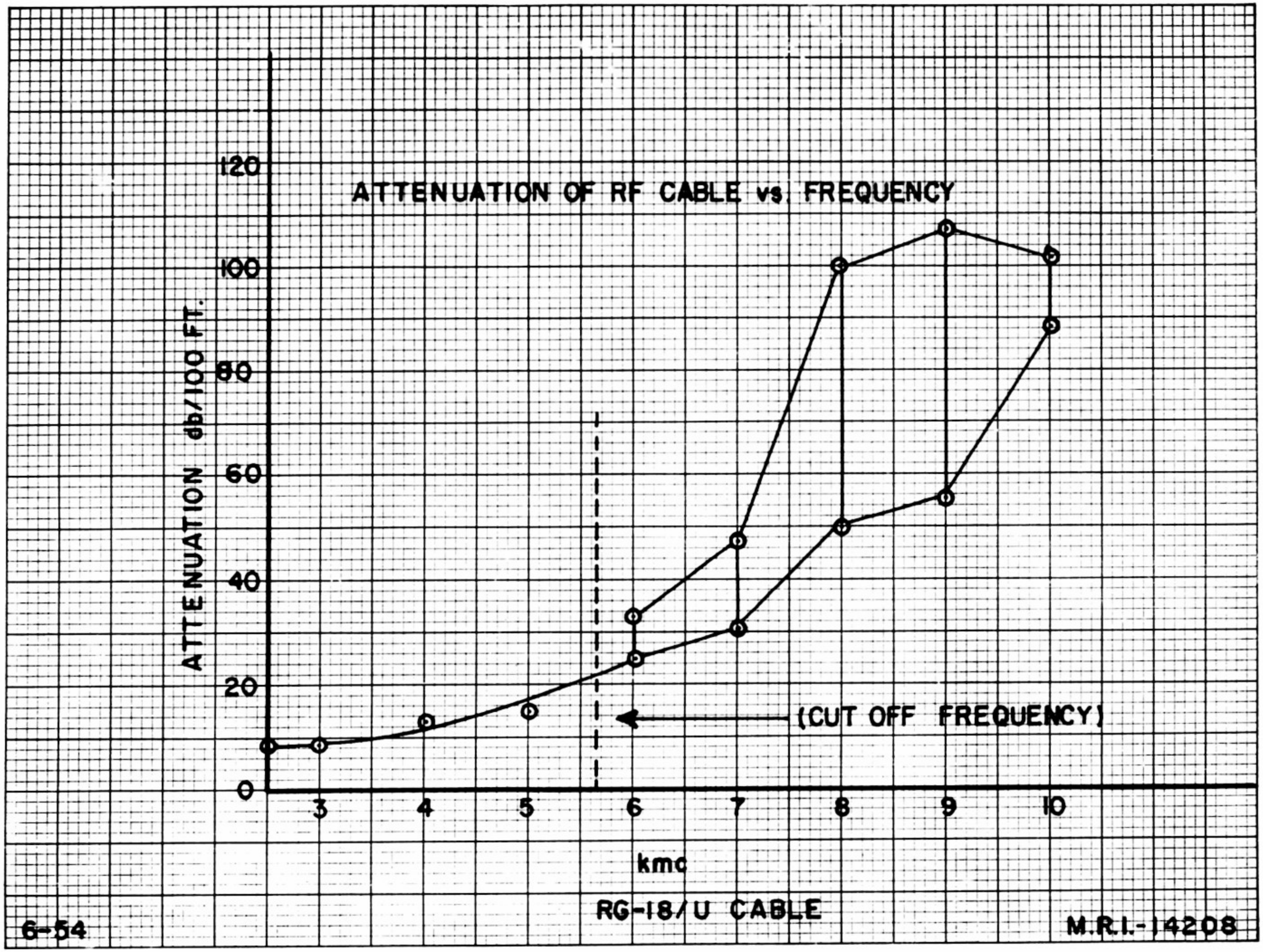
6-54 M.R.I. -14223

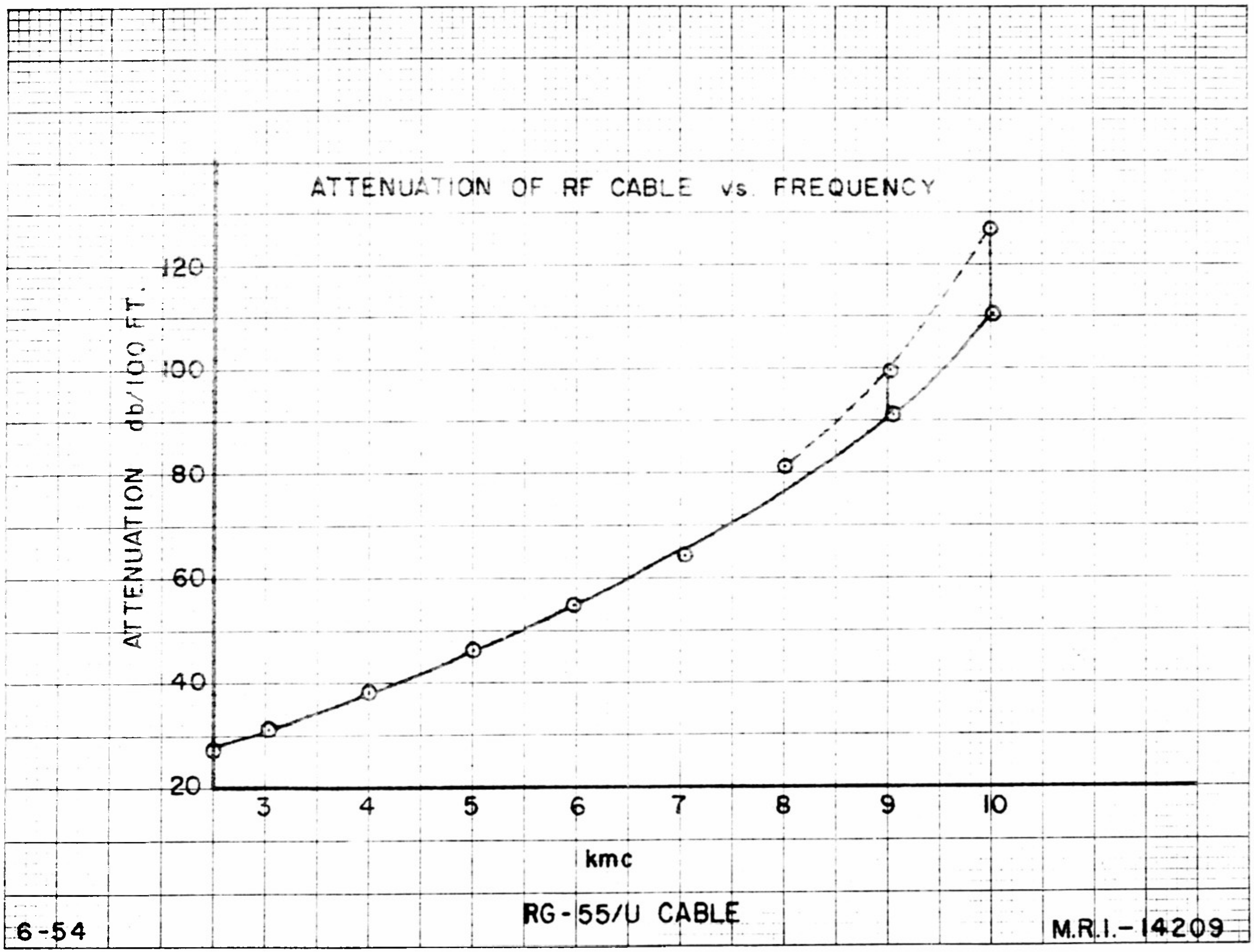


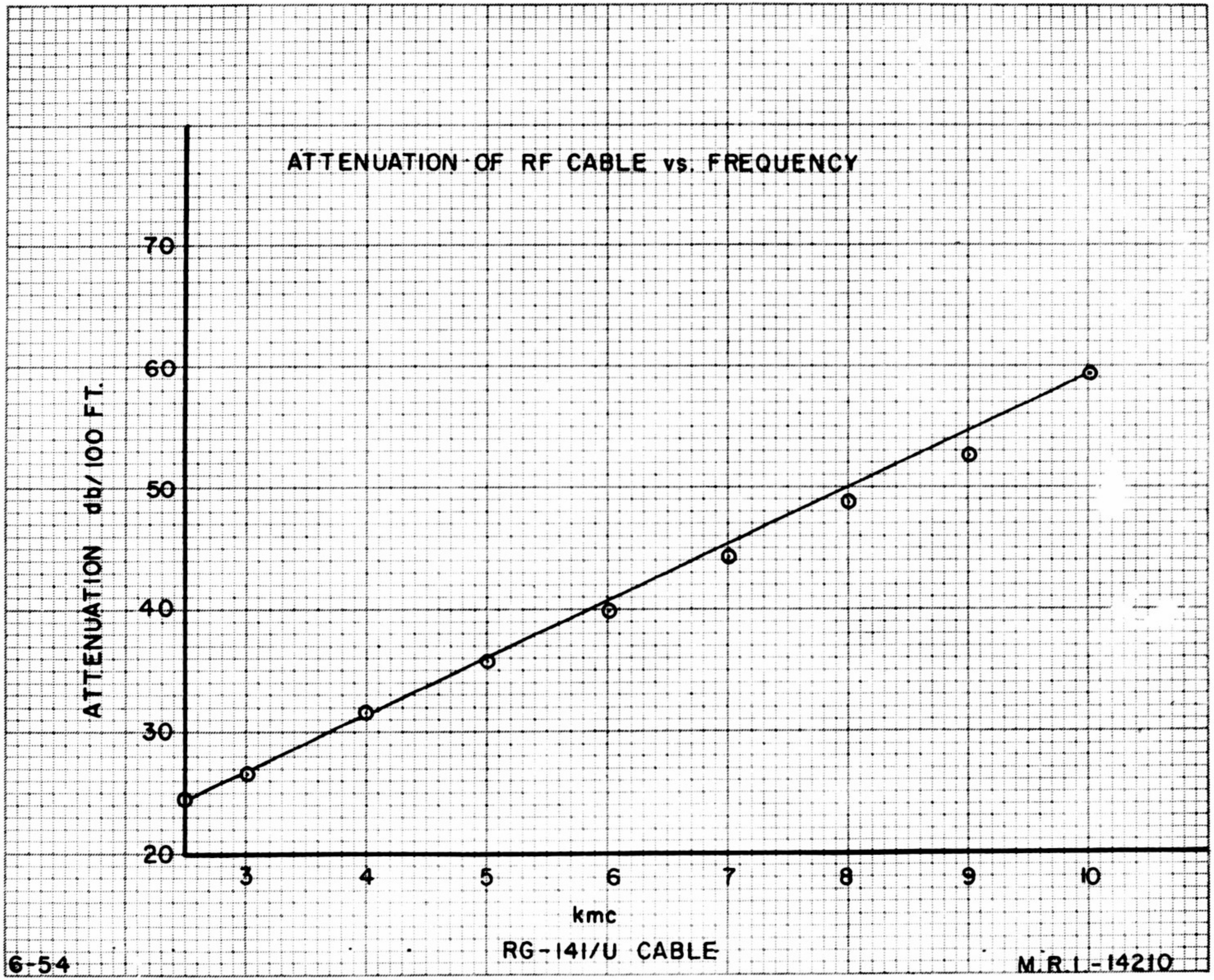
6-54
M.R.I.- 14224


ATTENUATION OF RF CABLE vs FREQUENCY
ATTENUATION db/100 FT.
260
220
180
140
100
60
20
2.5
3
4
5
6
7
8
9
10
kmc
RG-8/U CABLE
6-54
M.R.I. - 14206

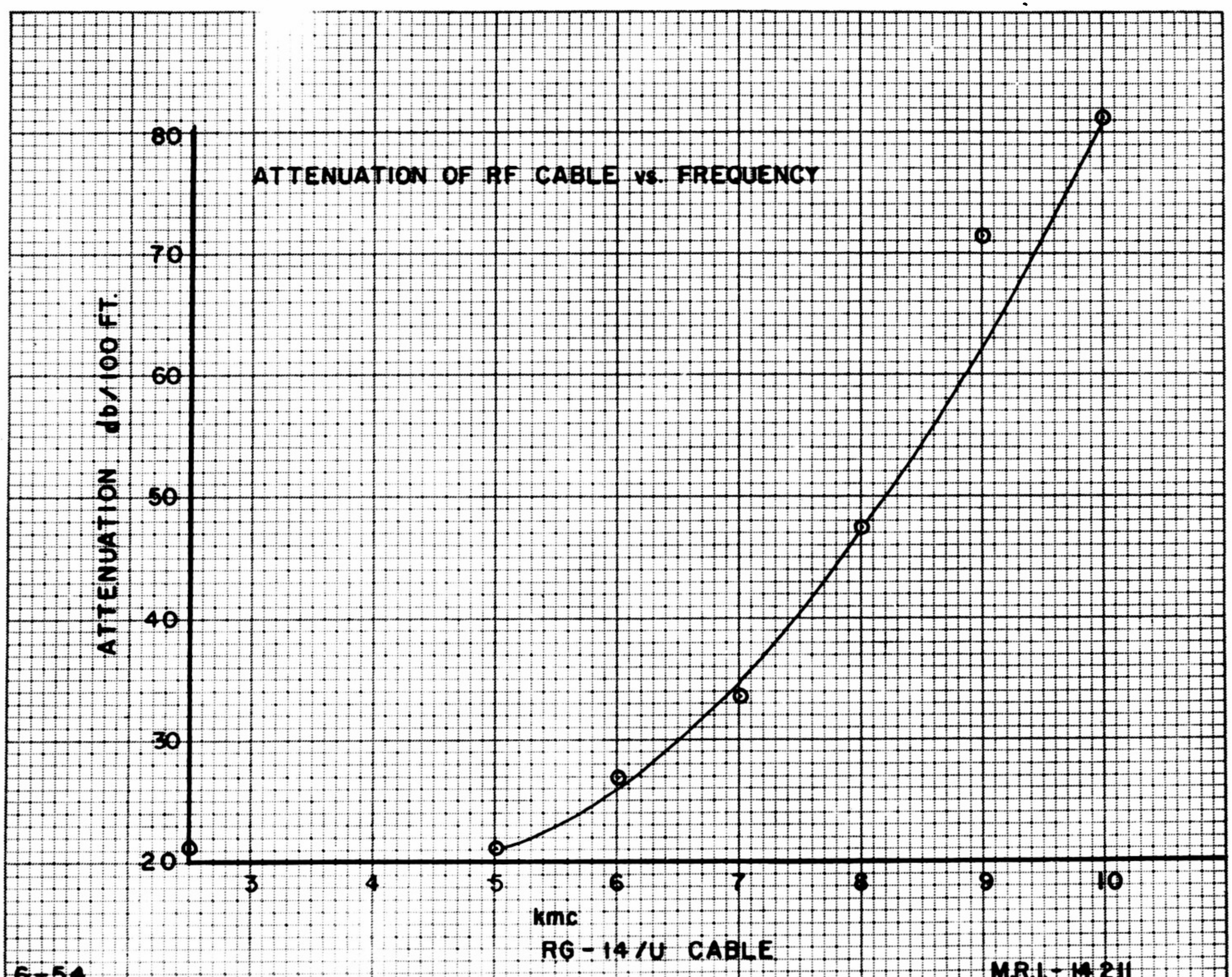

ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100FT.
10
20
30
40
50
60
70
80
90
100
3
4
5
6
7
8
9
10
kmc
6-54
RG-10A/U CABLE
M.R.I.-14207

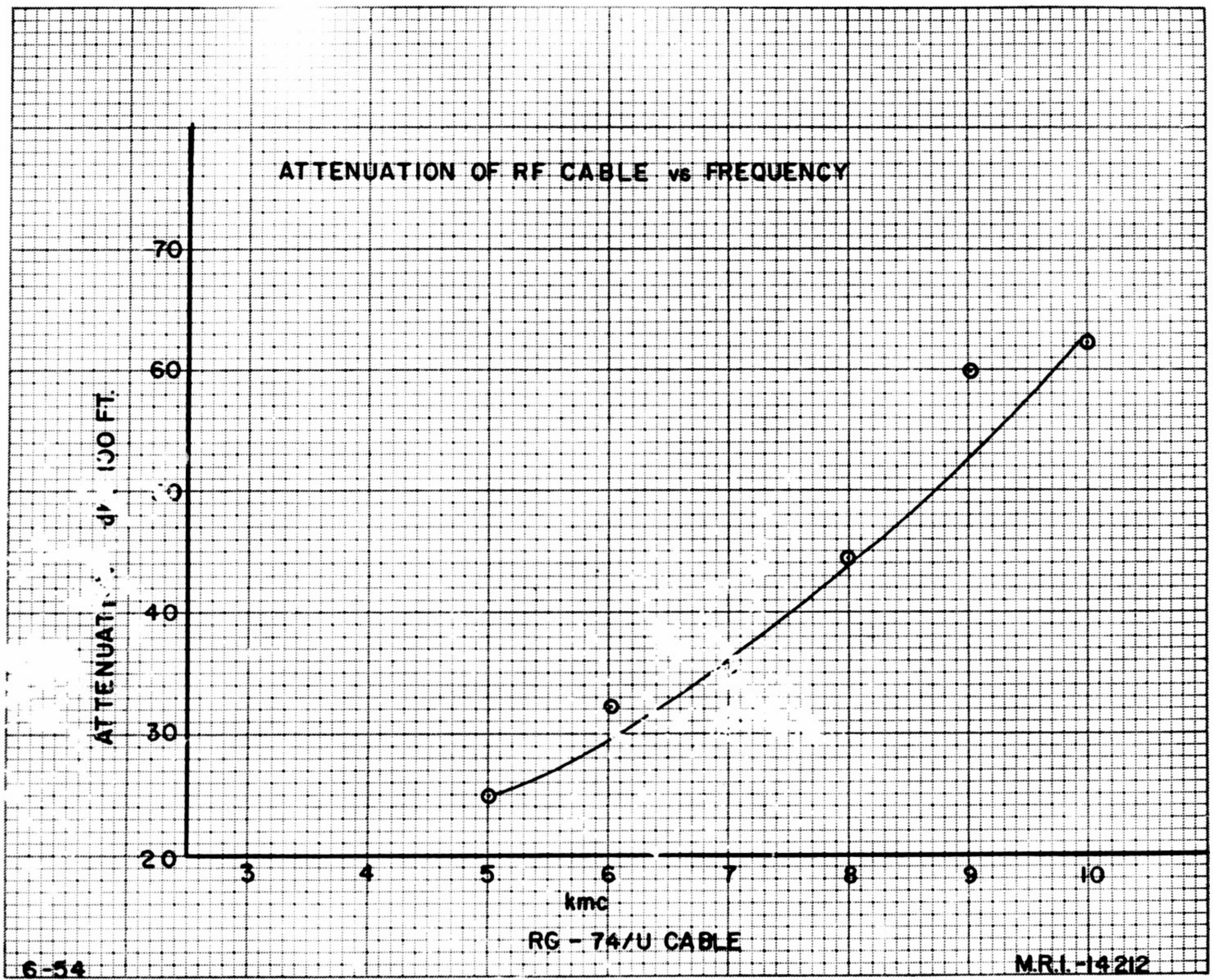

ATTENUATION OF RF CABLE vs FREQUENCY
ATTENUATION db/100 FT.
120
100
80
60
40
20
0
3
4
5
6
7
8
9
10
kmc
(CUT OFF FREQUENCY)
RG-18/U CABLE
6-54
M.R.I.-14208

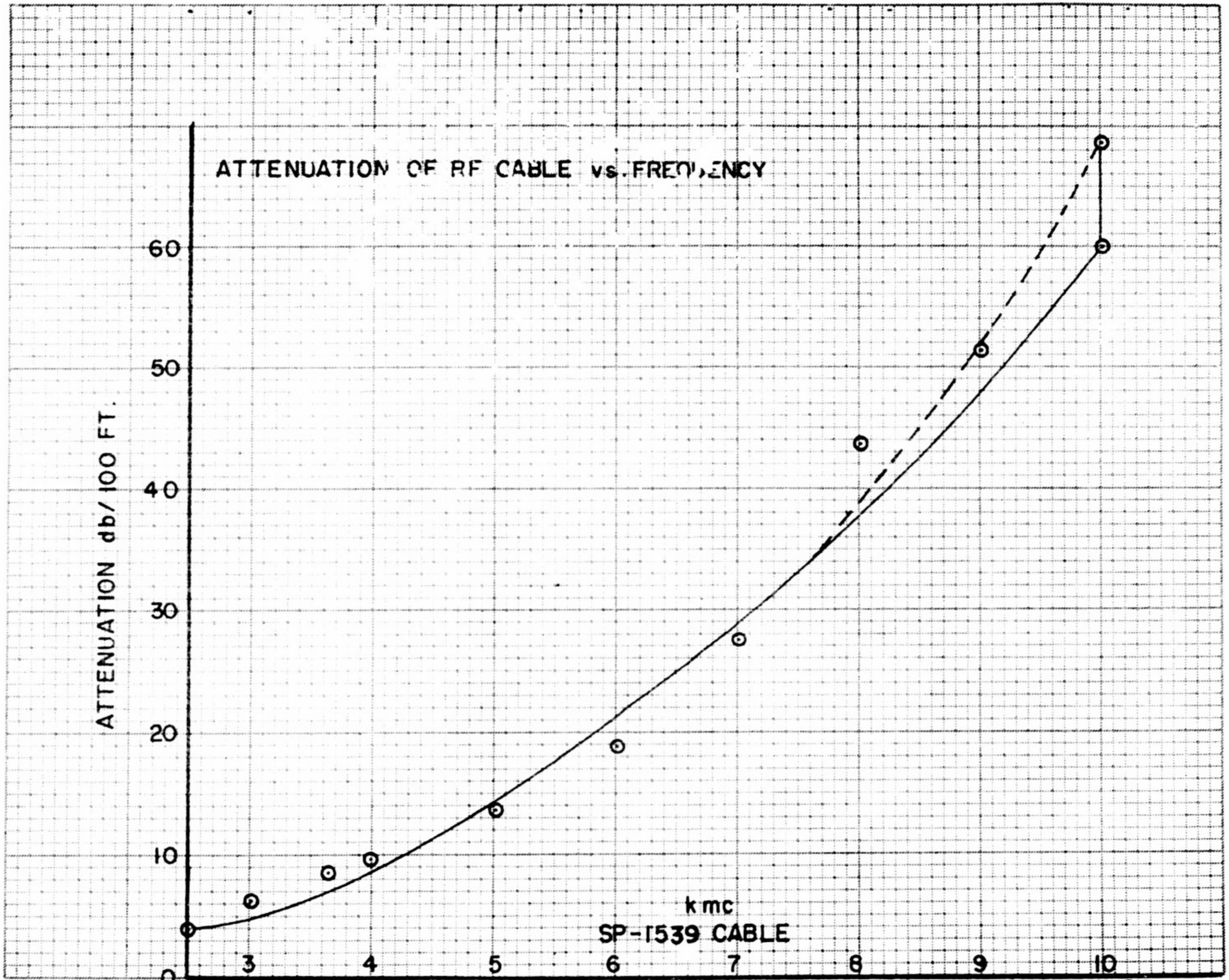

ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
120
100
80
60
40
20
3
4
5
6
7
8
9
10
kmc
RG-55/U CABLE
6-54
M.R.I.-14209



ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
70
60
50
40
30
20
3
4
5
6
7
8
9
10
kmc
RG-141/U CABLE
6-54
M.R.I.-14210

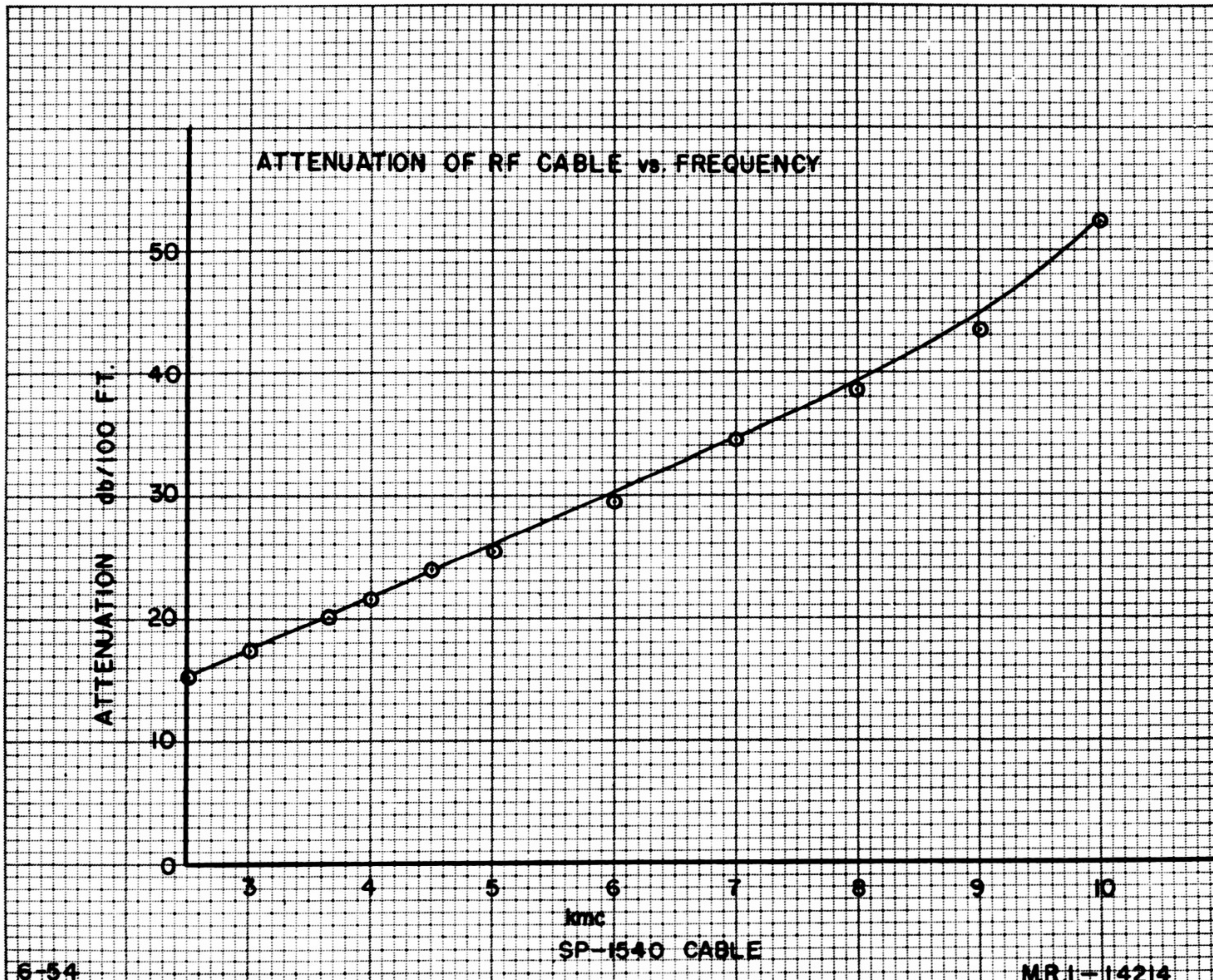

ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
80
70
60
50
40
30
20
3
4
5
6
7
8
9
10
kmc
RG-14/U CABLE
6-54
M.R.I.-14211


ATTENUATION OF RF CABLE vs FREQUENCY
70
60
40
30
20
3
4
5
6
7
8
9
10
kmc
RG - 74/U CABLE
6-54
M.R.I.-14212

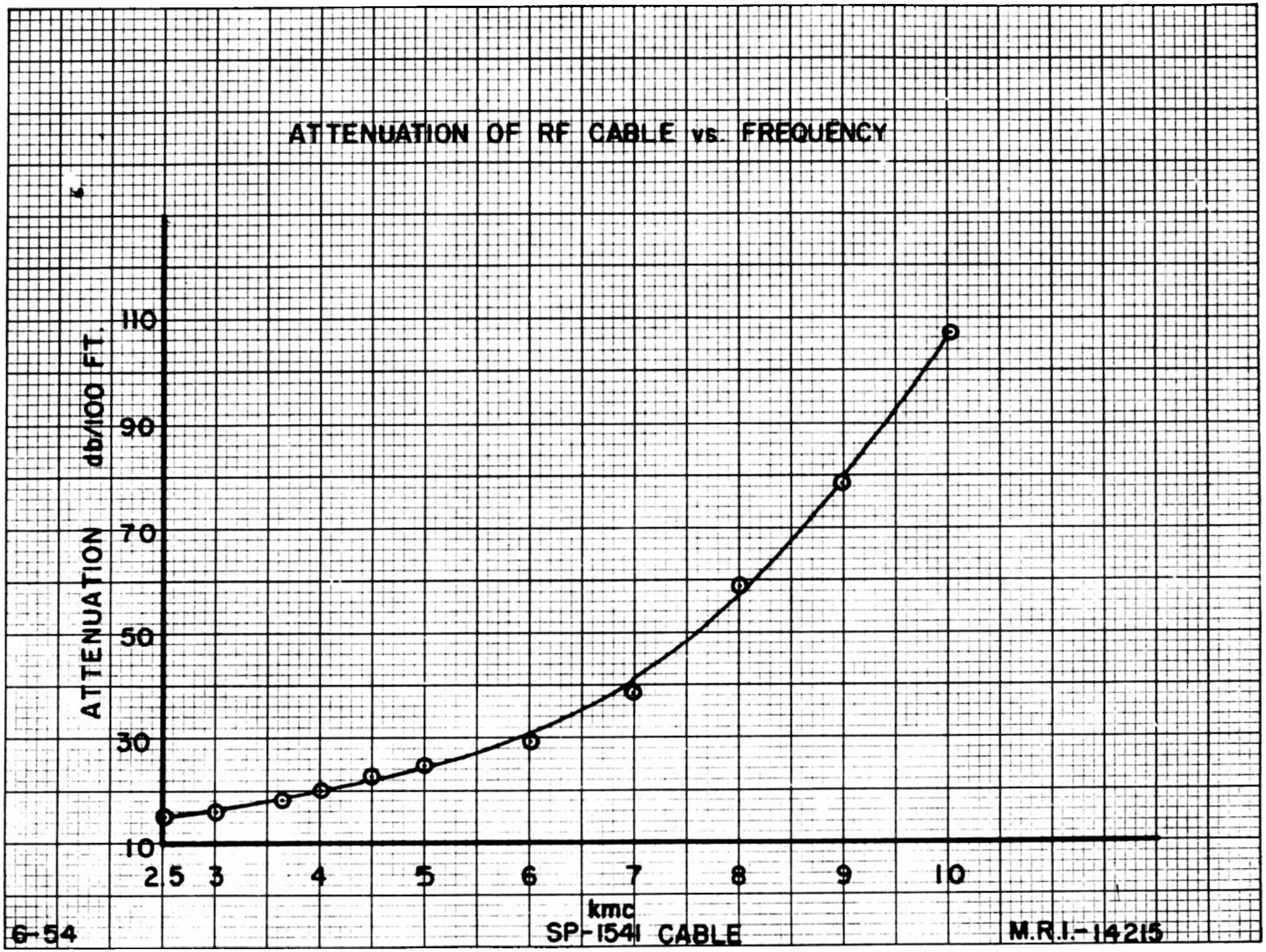


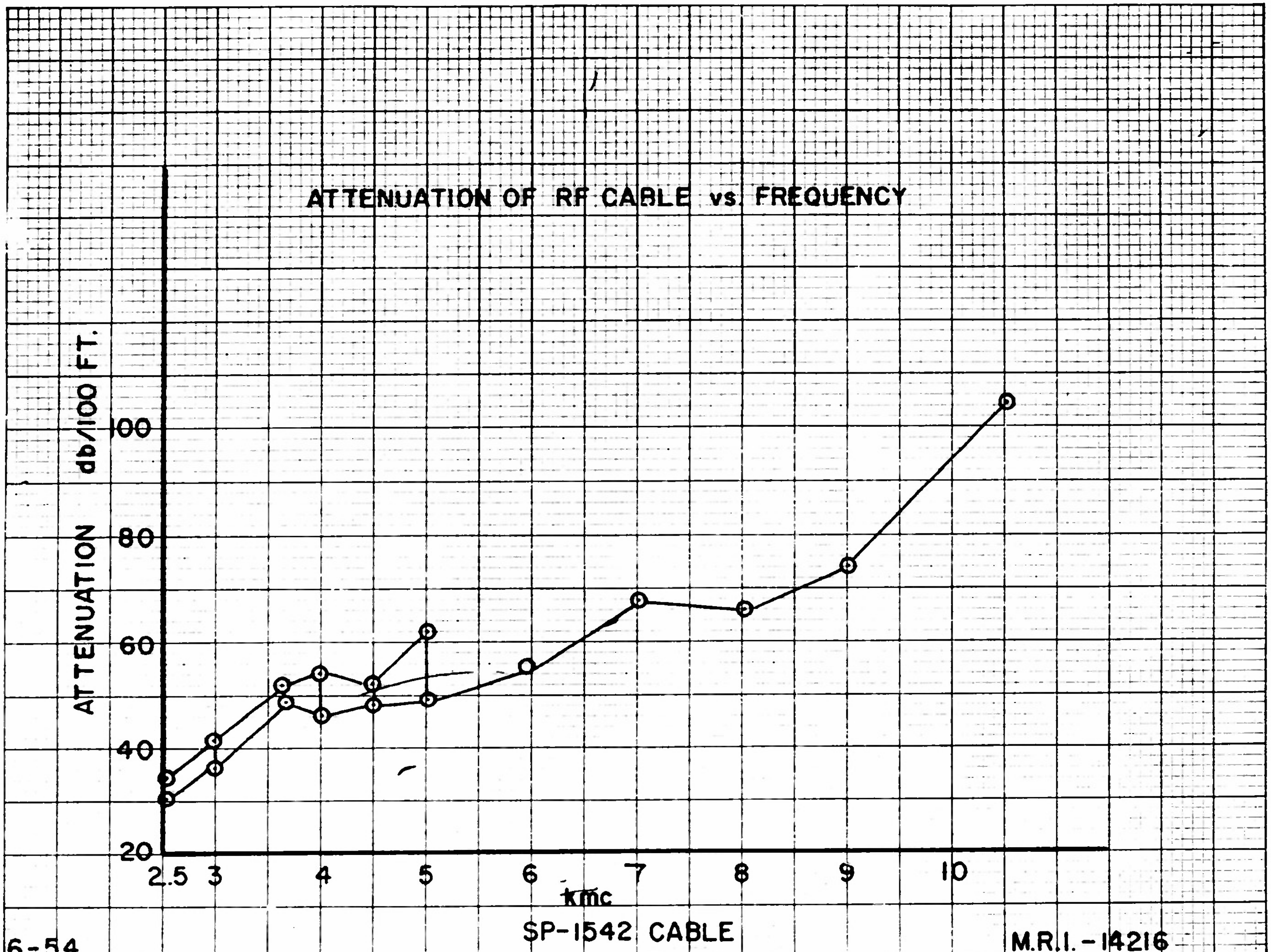
6-54

M.R.I.-14213

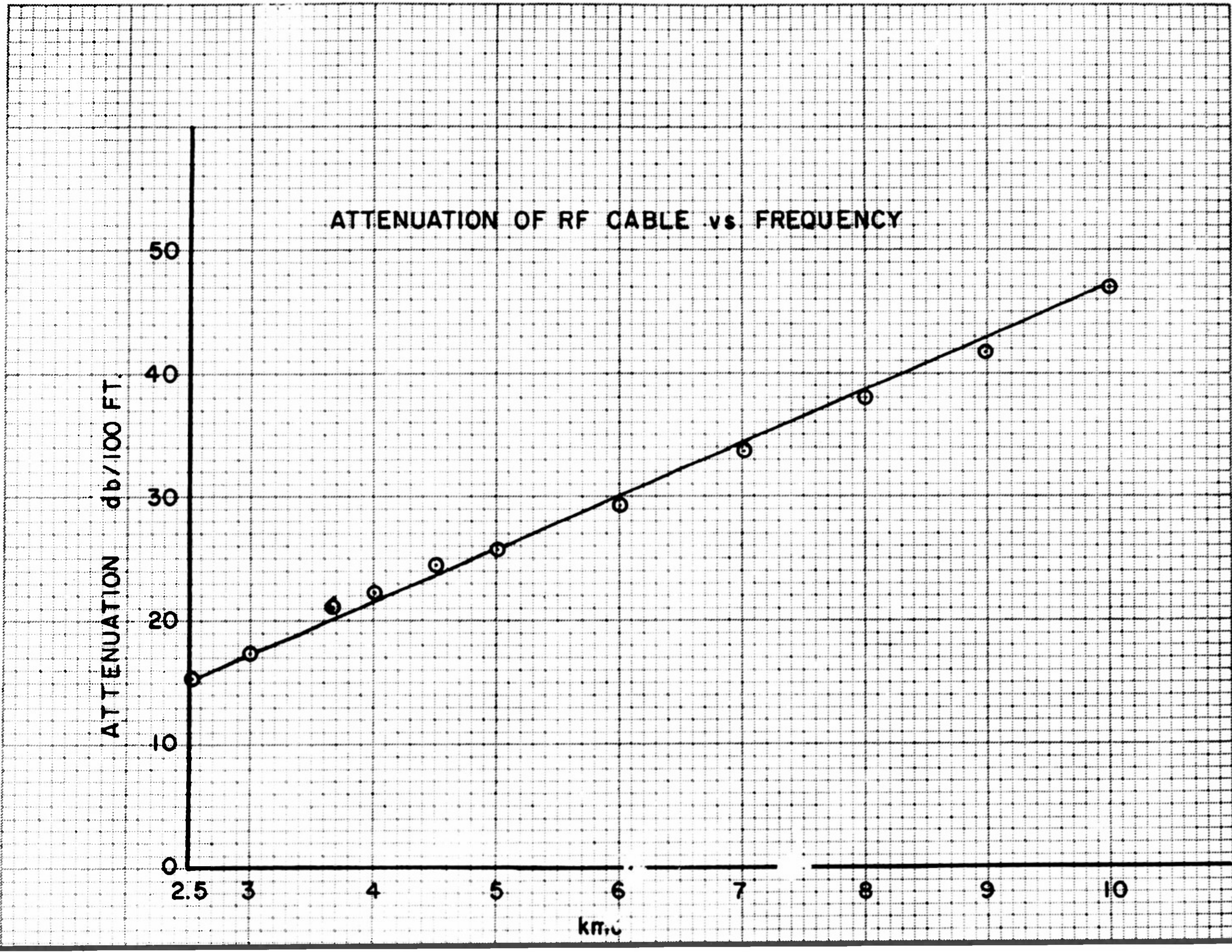


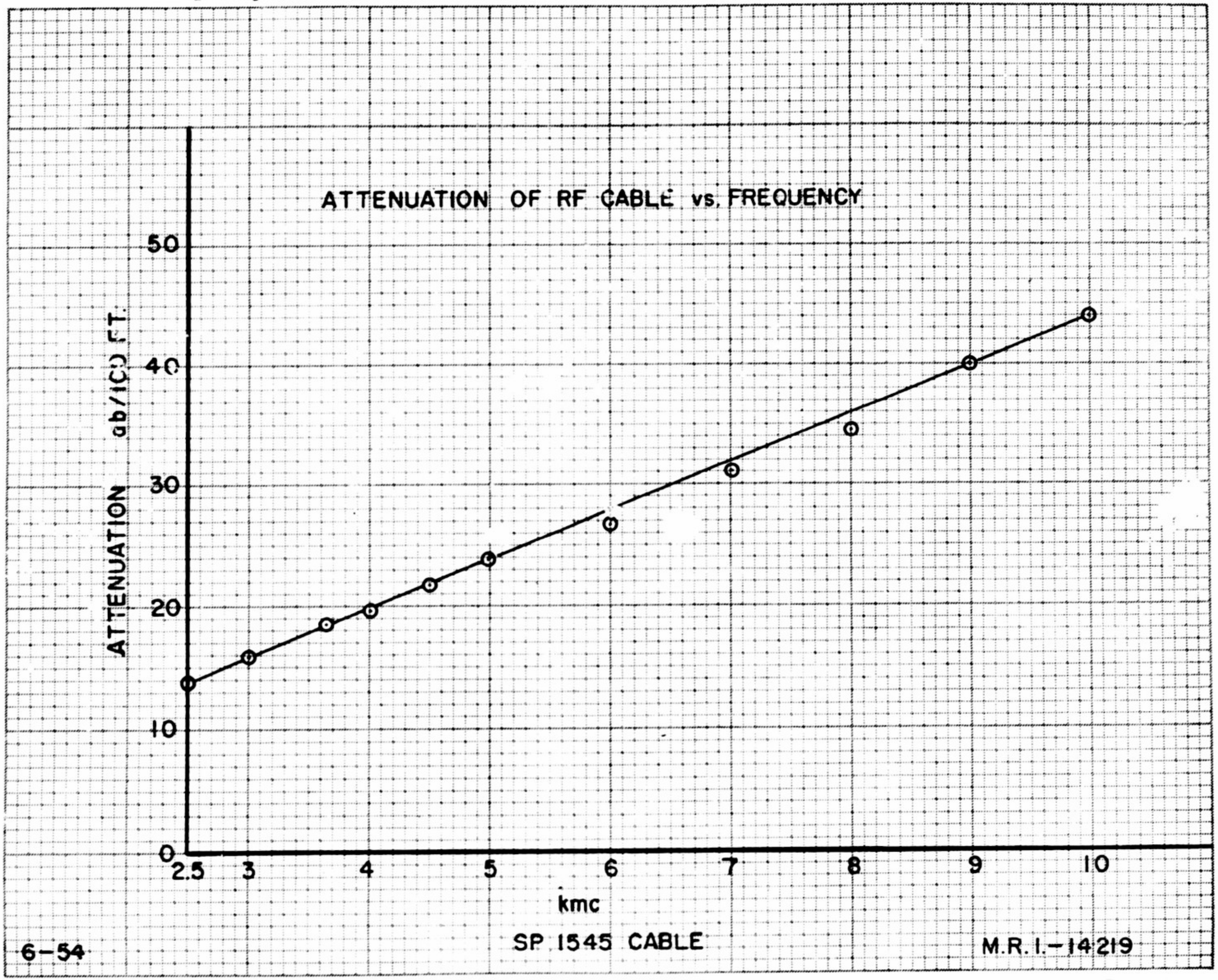
ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
50
40
30
20
10
0
3
4
5
6
7
8
9
10
kmc
SP-1540 CABLE
6-54
MR.I.-14214

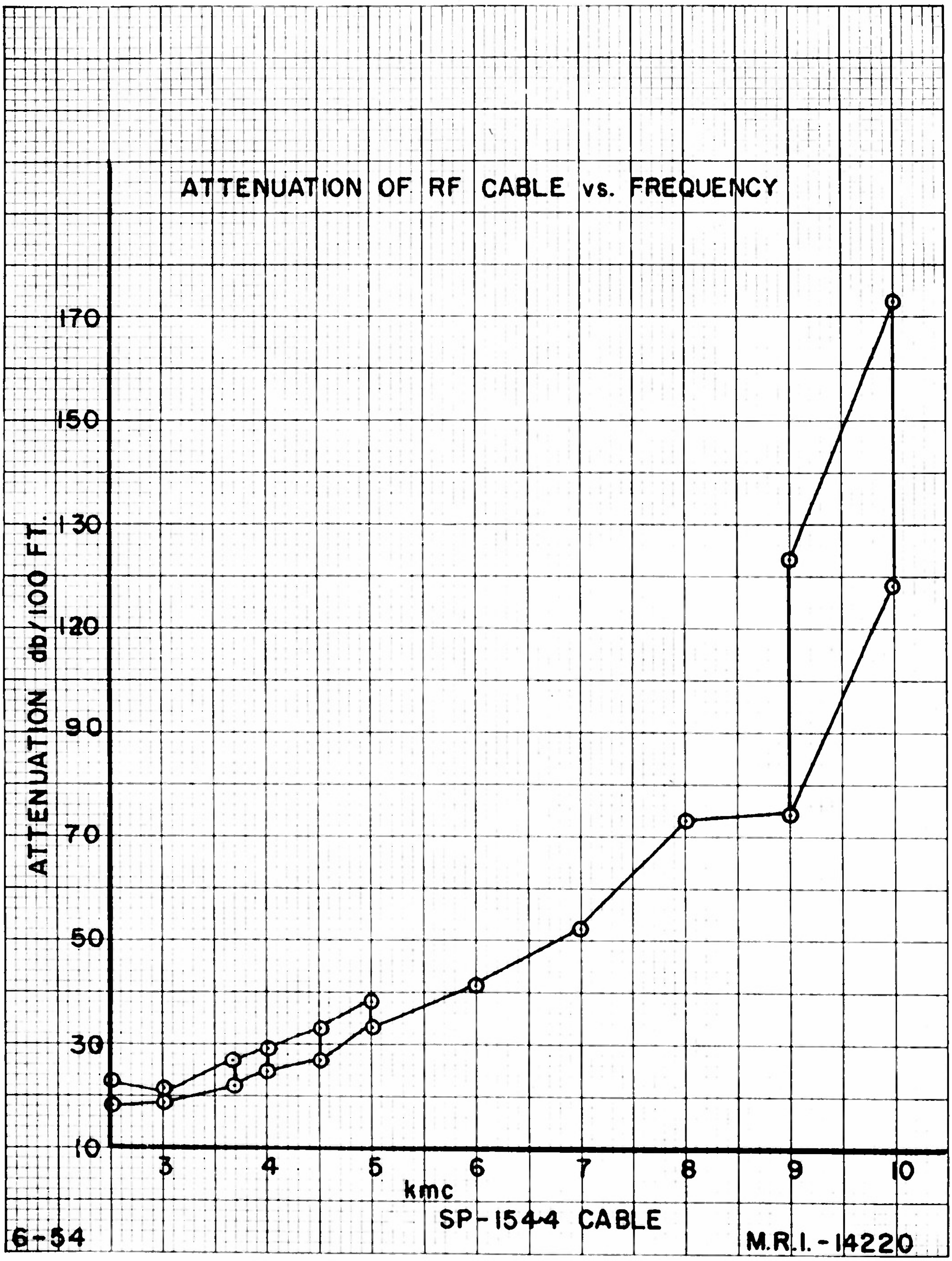

ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
110
90
70
50
30
10
2.5
3
4
5
6
7
8
9
10
kmc
SP-1541 CABLE
6-54
M.R.I.-14215



ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
100
80
60
40
20
2.5
3
4
5
6
7
8
9
10
kmc
SP-1542 CABLE
6-54
M.R.I. - 14216


ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
50
40
30
20
10
0
2.5
3
4
5
6
7
8
9
10


ATTENUATION OF RF CABLE vs. FREQUENCY
ATTENUATION db/100 FT.
50
40
30
20
10
0
2.5
3
4
5
6
7
8
9
10
kmc
SP 1545 CABLE
M.R.I.-14219
6-54


ATTENUATION OF RF CABLE vs. FREQUENCY
170
150
130
120
90
70
50
30
10
ATTENUATION db/100 FT.
3
4
5
6
7
8
9
10
kmc
SP-154-4 CABLE
6-54
M.R.I.-14220